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Shift of conventional millimeterwave window with variation of atmospheric parameters and applications

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Abstract The atmospheric constituents oxygen and water vapour mainly controls the clear air absorption of millimeter waves Both of these constituents have certain resonance absorption frequencies In between the resonance frequencies of O_2 and H_2O contents of atmosphere there are certain window frequencies where the absorption of millimeter waves are minimal All round the World Scientists, technologists, industrialists and users of millimeterwave communication Radar and Remote Sensors presume the millimeterwave window frequencies at 35, 94, 140 and 220 GHz, to utilize the lowest atmospheric attenuation and lowest equivalent thermal emission noise at the window frequencies However, the window frequencies are subject to shift with variations of the atmospheric water vapour content and temperature We, therefore, studied the millimeterwave window shift by using the theoretical Liebe model, which is the best one of the variety of theoretical models We, in fact, started the estimates of atmospheric windows for the Tropical regions in India and subsequently estimated the window frequencies in the temperate regions of the World, finding that the conventional window frequencies is shifted down sufficiently in tropical region countries

Keywords Millimeterwave window shift, atmospheric parameters, applications

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1. Introduction

The conventional millimeterwave windows at 35, 94, 140 and 220 GHz are being utilized world over, for LOS links, Radar and Radiometric imaging. However, increase of water vapour content of the atmosphere, shifts the conventional window frequency downwards. The most significant window shift in India occurs for the 94 GHz conventional window frequency, down to about 74–82 GHz, while conventional 35 GHz window frequency is shifted down to 31–32 GHz [1] Studies of window shift in different countries all over the world were made, indicating that no where in the world the real window frequency is equal to conventional window frequency, except that around Antarctic region or similar dry and low temperature regions. In view of this, millimeterwave LOS links, Satellite links, Radar and Radiometers for remote sensing, should be modified to realistic window frequency for optimising the sensitivity of the operating systems due to low atmospheric attenuation around the realistic window frequency [2].

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2. Estimation of atmospheric windows at millimeter waves Over International temperate regions

Estimation of atmospheric windows at millimeter waves using Liebe model well made for 10 different temperate areas in Western countries. The results, shown in Table 1, indicate that the frequency of the conventional window frequencies at 35, 94, 140 and 220 GHz are not valid in any of the regions, where the window frequencies, in fact, occur at frequencies lower than that of conventional window frequency.

3. Comparison of window shifts between tropical and temperate regions

The window frequencies at tropical regions, in general, occur at frequencies lower than those at temperate regions [3]. However, all the window frequencies shown in tropical and temperate regions in general, occur at frequencies lower than that expected as the conventional window frequency. This indicates that the choice of frequencies for millimeter wave LOS and satellite links should be dependent on the area, where this will be setup and the window frequencies to be used there should be estimated instead of using the conventional window. The results of window shifts over India is shown in Table 2.

Table 1. Millimeterwave window variations in different International Countries

Country	Station	Window frequency (GHz)	Window frequency (GHz)	Window frequency (GHz)	Window frequency (GHz)
Europe	Bodo VI (CIV/MIL) 67 17N, 14 22E	30–30 2	83–86	129–130	214
	Whithorn 54 42N, 4 25W	30	84 85	129	214
	Schleswig 54 32N, 9 33E	30–30 2	83–86	129 131	214
	Hohn (Ger-Afb) 45 19N, 9 32E	29–31	80–87	127–131	213–214
	Kirensk 57 46N, 108 04E	28 31 3	79–91	127–134	213–214
Mid Asia	Ekatering-Nikol'sko 47 44N, 130 58E	26 30	82–86	130–137	210–214
South Asia	Jeddah/King 21 40N, 39 09E	31	81	127	213
	Karaikal	31 4	61 6–77	125–141	198–212
Africa	Santa cruz Tenerife 28 28N, 16.15E	28–30	80–87	131–135	213–214

Table 2. Millimeterwave window variations in different Indian locations

Place	Window Freq (GHz)	Freq (GHz)	Freq (GHz)	Freq (GHz)
Ahmedabad (23 03 N, 72 4E)	31–32	74–80	124–125	214–215
Bhubaneswar (20 15N, 85 52E)	31–32	74–79	124–126	214–215
Mumbai (18.55N, 72 54E)	32	74–77	124–125	214–215
Kolkata (22 34N, 88.24E)	31–32	74–78	124–126	214–215
Cochin (09.58N, 76 17E)	31–32	74–80	124–125	214–215
Guwahati (26 11N, 91 47E)	31–32	74–79	124–125	214–215
Hyderabad (17 20N, 78 30E)	31–32	75–79	124–126	214–215
Goa/Panjim (15 30N, 73.55E)	31–32	75–81	124–127	214–215
Jodhpur (26 18N, 73 04E)	31 32	75–81	124–127	214–215
Lucknow (26 55N, 80 59E)	31–32	74–80	124–126	214–215
Chennai (13 04N, 80 17E)	32	74–76	124	214–215
Minicoy (08 10N, 73 00E)	31–32	74–77	124–125	214–215
Nagpur (21 09N, 79 09E)	31–32	75–80	124–126	214–215
New Delhi (28 38N, 77 12E)	31–32	74–82	124–127	214–215
Port Blair (11 41N, 92 43E)	32	74–76	124	215
Srinagar (34 06N, 74 51E)	31–32	76–83	125–127	214 215
Trivandrum (08 29N, 76 59E)	31–32	74–77	124–125	214–215
Vishakhapatnam (17 4N, 83 2E)	31–32	74–78	124–126	214 215

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